

Article

# “What a mobility-limited world”: Design Requirements of an Age-friendly Playable City

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**Abstract:** A key concern in an ageing society is citizens’ mobility. As populations age, disability impairments can affect active ageing, health-related wellbeing and quality of life. In this paper, we present the on-going research project SeriousGiggle – Game-based learning for triggering active ageing. Its goal is to assess the potential of game-based learning for active ageing and contribute to a sense of wellbeing and quality of life. It also seeks to improve the mobility of older adults by creating a set of journey plans with route guidance that are rated in terms of safety, community support, environment and age-friendliness. Drawn on our field work with 33 co-designers, 40 end users and 10 semi-structured interviews with Subject Matter Experts, we identify a set of necessary design requirements to an Age-friendly Playable City. This study recommends the use of gamification and playful techniques to engage the end-users to provide information about local traffic signs, pavement conditions, wayfinding and, therefore, help to create route guidance and walking assistance that are personalized to older adults’ context in terms of location, travel fitness, mobility impairments and motivations.

**Keywords:** Playable City; Age-friendly environments; Games; Mobility; Active ageing

## 1. Introduction

Mobility and physical activity play a vital role in the individuals’ daily-life activities, wellbeing and quality of life [1, 2]. The ageing process is a personal trajectory built over the years [3] and, therefore, creating awareness about dietary intake and fostering safe physical activities are essential in order to both prevent sarcopenia [4] and the risk of certain diseases – e.g. hypertension, diabetes and cholesterol [4, 5, 6, 7]. Furthermore, physical activity can be beneficial by (a) strengthening the muscles [8, 9] (p.25); (b) improving agility, posture, stress tolerance, sleep and mood [8, 9]; (c) preventing excessive weight gain and reducing the risk of fracture and frequency of falls [8, 9]; (d) improving cognitive function and confidence [8, 9]; and (e) reducing depression and anxiety [8, 9].

According to the International Classification of Functioning, Disability and Health [10], mobility impairments can occur at different stages: Changing and maintaining body position;

Carrying, moving and handling objects; Walking and moving; and Moving around transportation. These impairments do not only challenge the interface design in urban, mobile and home spaces but also open up a set of opportunities to rebuild the cities in terms of safety, community support, environment and age-friendliness.

Although there has been an increasing interest in the use of game strategies and elements applied to physical exercise [11, 12, 13], there has been little published data on its use for encouraging active ageing through mental and emotional representations of player-citizens in their environment [11], and encompassing equally important dimensions, other than health, – i.e. security and participation in society [12]. The playable city movements, in which the inherited services, stories and places are determined by own citizens [11, 12, 13], have also reinvented the way people interact and move within the city [11, 12, 13]. However, building playable cities, which are equally age-friendly and inclusive seems to be unconsidered in both literature review and/or current social policies.

The aim of this paper is to identify a set of necessary design requirements for designing an Age-friendly Playable City. Specifically, we (a) identify a set of recommendations for designing age-friendly environments, and (b) discuss in what way these can be applied for engaging individuals in a Playable City that is more accessible in terms of journey plans and route guidance.

## 2. Materials and Methods

The purpose of this research project **SeriousGiggle** is to assess the potential of game-based learning for active ageing and contribute to a sense of wellbeing and quality of life. It also seeks to improve the mobility of older adults by creating a set of journey plans with route guidance that are rated in terms of safety, community support, environment and age-friendliness.

This exploratory mixed-method research is divided into the following three phases: PHASE 1 – The Participatory Action Qualitative Research, in which a group of 33 adult learners at a University of Third Age were involved in the design process of a game-based (GBLP) and computer-assisted learning programs (CALP); PHASE 2 – The Quantitative Experimental Research, in which two treatment counterbalanced groups tested a game-based and a computer-assisted learning program and assessed these in terms of their perceived health-related wellbeing and quality of life before and after each experiment (SF36v2 and WHOQOL-BREF); and PHASE 3 – The Mixed-Method Approach, in which groups discuss pros and cons of each experiment and then proceeding to a set of interviews with a group of experts in order to propose a set of recommendations for designing such digitally-mediated and age-friendly environments.

This paper will focus on PHASE 3 – The Mixed-Method as this paper is an extension of the conference paper presented at SEGAH 2018- *Breaking barriers to game-based learning for active ageing and lifestyles: A qualitative interview study with experts in the field* [14] and further information about the process and other phases are described in the following papers: *Games for active ageing, well-being and quality of life: a pilot study* [15], *Co-designing a Game-based Learning Platform for Active Ageing: The Case of 'Jump'* [16], and *Demystifying Ageing Bias Through Learning: Co-designing an Online Course about 'Ageing Well'* [17].

### 2.1. Previous assessment of the perceived benefits and motivations to Physical Exercise with the co-design group

A group of 33 adult learners at a University of Third Age were assessed in terms of their context and involved in the design of the GBLP and CAP (48.5% male and 51.5% female, M = 67 years old, minimum = 55; maximum=82) and data were collected from March 2015 to December 2016.

Concerning Physical Exercise, the participants were asked whether they practiced any Physical Exercise and about the reason for doing or not doing it. The participants were, therefore, given a list of statements based on the World Health Organization's potential benefits for practicing Physical Exercise [8] and [9] to rate from 1 to 5 their level of (dis) agreement:

- 'Doing exercise with people of the same age is good for socializing';

- ‘Doing exercise in a balanced way is essential to good health’;
- ‘Doing exercise helps me to relieve anxiety and cope with emotions’;
- ‘Doing physical exercise in groups is more fun than individual exercises’;
- ‘Physical exercise is important to general health.’

After showing some examples of the use of Technology in Physical Exercise and discussing the role of technologies in Health, they were asked about the main functionalities that they would like to have in a learning program related to Physical Exercise. The following options based on those examples and discussion were provided:

- ‘Creation of events related to Physical Exercise’;
- ‘Schedule Physical Exercises’;
- ‘Creation of a plan of Physical Exercise’;
- ‘Share the progress of Physical Exercise’;
- ‘Compare the progress of Physical Exercise with friends’;
- ‘Associate a reward system to Physical Exercise’;
- ‘Audio-visual tutorials related with exercises to practice’
- ‘Simulations on exercises to practice’;
- ‘Other.’

2.2. Game design relative to physical exercise

Based on the definition of active ageing presented by the WHO [12] and the participants’ context a game-based learning program was developed. The game plot is the following: “Sul, the fisherman is tired of getting stuck to a routine that he never got used to. Depressed and isolated, Sul has to face the storyteller Nubel, who forces him to a time travel experience, in order to recover values and have a significant meaning to his own life.”

In the game missions, a set of challenges related with Physical Exercise were also included (i.e. Strength, Flexibility, and Equilibrium exercises) that can be performed both indoor and outdoor (Figure 1 and Figure 2).

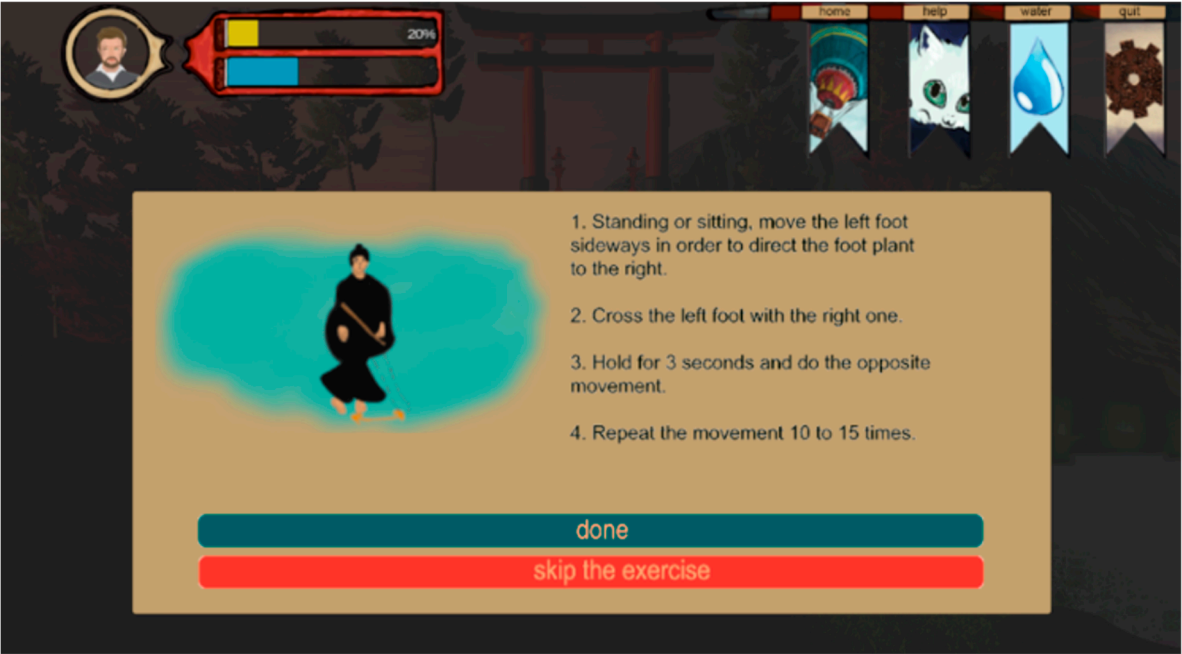
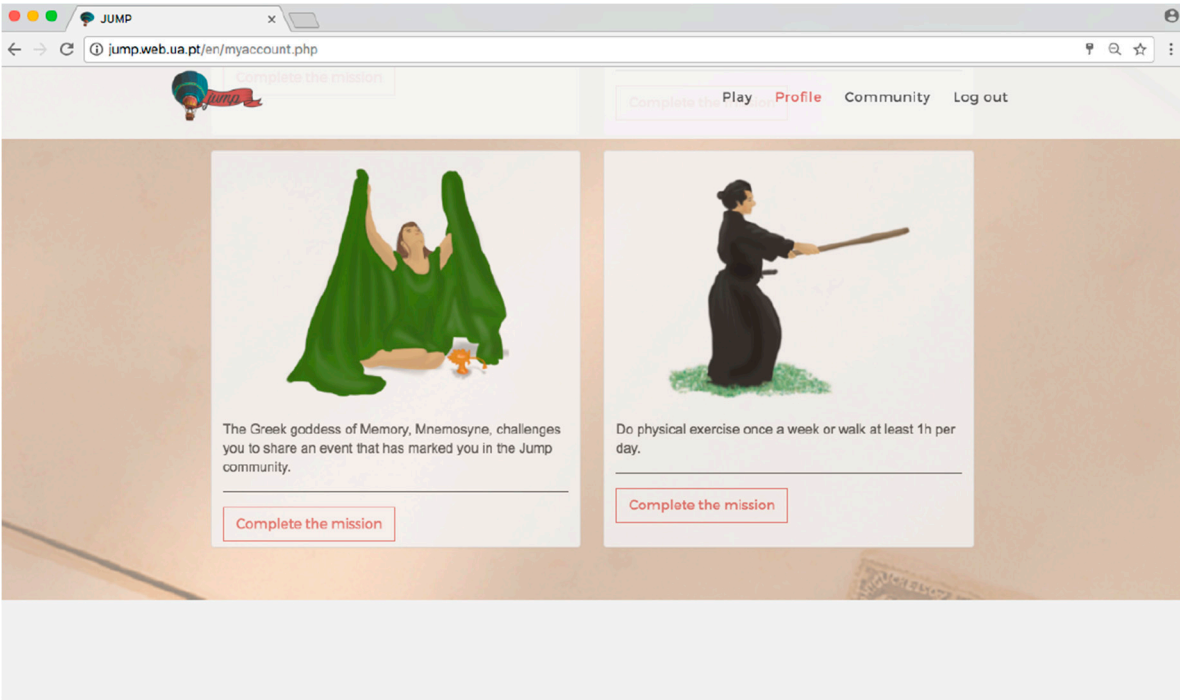
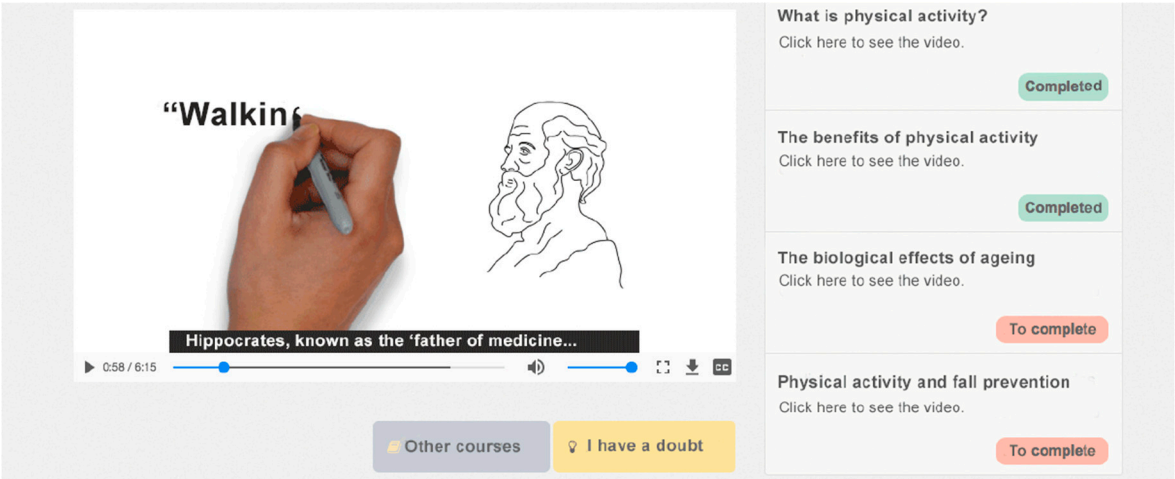


Figure 1. In-game missions related to Physical Exercise



**Figure 2.** Off-game missions related to Physical Exercise

These missions are embedded in the game plot, in which the character Sul travels to the Hizen Province, 1709 to meet the history-based and non-player character (NPC) – the Samurai Yamamoto Tsunetomo, who encourages the player to do the exercises by giving his practical and advices on how to be a Samurai warrior (published in the book ‘Hagakure’). The player can also find information about the benefits of physical activity, the biological effects of ageing and recommendations on fall prevention. The same contents were covered in an online video-based course (Figure 3), aiming at comparing its effectiveness with the game [17].



**Figure 3.** Off-game missions related to Physical Exercise

### 2.3. Cooperative evaluation

After the co-design process and game development (PHASE 1 and 2), a cooperative evaluation with 40 adult learners was performed. This cooperative evaluation aimed to identify the main strengths and problems of the platforms to encourage active ageing and healthy lifestyles.

2.4. Interview with Subject Matter Experts

A group of experts (N=10) in the fields of Games, Human-Computer Interaction, Psychology, Marketing and Ageing Studies were interviewed. These experts met the following selection criteria: (a) voluntary participation; and (b) being familiar with games, or/and learning and changes in behaviour, or/and age-friendly environments. Out of the 53 invitations sent, there were 10 acceptances, 2 refusals and 40 no answers.

The purpose of the interviews was twofold: (a) acquire the experts’ perspective on the use of games in learning and changes in behaviours; and (b) understand the role of digitally-mediated approaches to meet the challenges of the ageing process. As such, audio recorded semi-structured individual interviews were held between July and October 2017 with 10 interviewees (8 males and 2 females), researchers and practioneers in the game industry (Table 1). Face-to-face interviews took place at Coventry University and others were conducted on teleconference, videoconference or e-mail, being audiotaped and transcribed.

Table 1. The Interviewees’ general information

ID	Context	Description
1	Educational Sector	Researcher in User Experience and Information Architecture. Professor in Computer Science with a vast experience in joint academia-joint academia-industry projects (e.g. Microsoft, Nokia)
2	Both	Freelance game designer, consultant and lecturer. Experience in game development and previous involvement in such game projects as the ones carried out by Bullfrog Productions or Madden NFL Football.
3	Industry	Vast experience in the game industry and consultant in monetization, videogames and gamification. Relevant game projects: Smashy City, Batman and The Flash: Hero Run, Jelly Jiggle and Farm All Day.
4	Educational Sector	Research Associate at the Disruptive Media Learning Lab. Background in Psychology with the following research interests: identities in online communities, learning practices and games.
5	Industry	Vast experience in the tabletop games industry and involvement in various game projects (i.e. triple A console MMOs and free-to-play games).
6	Industry	Vast experience in game design. Relevant game projects included SEGA Rally Revo and Colin McRar: DiRT Rally.
7	Educational Sector	Professor and Researcher with expertise in ‘silver gaming’ and the use of old and new media by older adults.
8	Educational Sector	Research fellow for the Behaviour and Interventions Research Group (Coventry University) and Public Health Warwickshire with the following research interests: evidence informed making, social marketing, health behavior change and eHealth.
9	Educational Sector	Researcher in Educational Technology and Learning Design at Simon Fraser University with a focus on ageing and technology. Research interests: digital games and digital storytelling with older adults and intergenerational relationships.
10	Educational Sector	Senior lecturer and researcher with background in Artificial Intelligence, in-game learning, computer games development and digital media. Research interests: Virtual reality and applications for learning and training.

A convenient time was arranged for both the interviewee and the interviewer and a protocol was used to conduct the interviews and analyse the data. This protocol was divided into the



following steps: 1. Introduction/Instructions and Standards Procedures; 2. Ice-breaker questions; 3. Four/five questions; and 4. A Thank-you statement.

Whereas Table 2 presents the questions used to interview Subject Matter Experts in the fields of Games/Human-Computer Interaction, Table 3 shows the ones posed to the experts in Psychology, Marketing or Ageing Studies.

The verbatim transcriptions were reread, coded using NVIVO and analysed by identifying and highlighting patterns in the interviewee’s statements. The codes used in this paper were: Recommendations for designing age-friendly environments and Designing for learning and behaviour change.

**Table 2.** Overview of the questions used to interview experts in the fields of games/human-computer interaction

Data Collection Questions	Data Analysis Questions
1. How can we attract the player’s attention to the information transmitted and changes in behavior through a game-based approach?	What are the main factors that can foster learning and changes in behavior?
2. In your opinion, what could be a pervasive game scenario for motivating active ageing and healthy lifestyles?	
3. Do you see gamification as a players’ mind-set solution or a game designer’s product? Why?	What’s the role of game designers in gamification?/What’s the role of players’ mind-set in gamification?
4. Can a gamified system work by extending actions that occur in the physical space to the digital one? What is your view on that?	
5. How can games generate a culture of care and prevention outside of the medical system?	What are the main factors that can generate a culture of care and prevention outside of the medical system?
6. In your perspective, what role can informational literacy perform in order to overcome the commercial war that can occur between changing or manipulating behaviors?	What are the main strategies that can be adopted in order to avoid manipulation of behaviors in <i>gamification</i> ?
7. What are the main misconceptions or drawbacks of these game-based approaches that game designers should take into account?	What are the drawbacks/challenges of the game-based approaches for learning and changes in behaviors?
8. What are the opportunities for gamification and serious games?	What are the opportunities for gamification and serious games?
9. In your opinion, what the future holds for serious games and gamification?	

**Table 3.** Overview of the questions used to interview experts in the fields of psychology and ageing studies

Data Collection Questions	Data Analysis Questions
1. What drives Human behaviors?	What are the main factors that can foster learning and changes in behavior?
2. In your opinion, can technologies trigger changes in behavior? If so, in what way?	What are the key technological features that can influence changes in behaviors?
3. How can we transform Human behaviors into daily routines?	What are the main factors that lead Human behaviors into habits/routines?
4. In your opinion, how can we create environments that are better places for encouraging active ageing?	What are the main features of an age-friendly environment?
5. In your perspective, what could the technology industry do to contribute to age-friendly contexts?	What are the opportunities for age-friendly technologies?
6. What challenges do you foresee in the new approaches to create age-friendly environments?	What are the challenges for age-friendly technologies?

*3.5. Ethical considerations*

This study has been approved by the Ethics Committee of the University of Aveiro (Resolution n.3/2015) that safeguards, among other things: (a) the informed consent of the participants aged 50 and over; (b) voluntary participation; (c) involvement of the research team in the process; and (d) that the risks of participating in the study do not outweigh the risks associated with the participants' daily lives.

**3. Results**

*3.1. Previous assessment of the perceived benefits and motivations to Physical Exercise with the co-design group*

When surveying the participants whether they practiced Physical Exercise, 54.5% (n=18) revealed that they do physical exercise at least 3 times per week due to the following reasons: Improve agility and posture (n=20; 60.6%); Prevent health problems (n=17; 51.5%); and Maintain and improve mobility (n=15; 45.5%). Six participants did not practice any physical exercise and pointed out the 'lack of motivation/interest' as being the main reason.

Results have also shown that most of the participants agreed that doing exercise with people of the same age was good for socializing (n=31; 94%). They also recognized that doing it in a balanced way was essential to good health (n=33; 100%) and helped them to relieve anxiety and to cope with emotions (n=31; 94%), being more fun in groups rather than individual exercises (n=32; 99%). Overall, Physical Exercise was stated to be important to general health n=32; 99%).

Table 4 shows the functionalities of a digitally-mediated program to encourage physical exercise.

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**Table 4.** Functionalities of a digitally-mediated program to encourage physical exercise

Functionalities	No important		Neutral		Important		No answer	
	N	(%)	N	(%)	N	(%)	N	(%)
Creation of events related to physical exercise	7	21.2	9	27.3	11	33.3	6	18.2
Schedule physical exercises	3	9.1	8	24.3	19	57.6	3	9
Creation of a plan of physical exercise	4	12.1	9	27.3	18	54.6	2	6
Share the progress of physical exercise	7	21.2	6	18.2	19	57.6	1	3
Compare the progress of physical exercise with friends	5	15.2	16	48.5	9	27.3	3	9
Associate a reward system to physical exercise	13	39.4	7	21.2	8	24.2	5	15.2
Audio-visual tutorials related with exercises to practice	9	27.3	11	33.3	9	27.3	4	12.1
Simulations on exercises to practice	7	21.2	6	18.2	15	45.4	5	15.2

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As shown in Table 4, the main functionalities that the participants chose were: schedule physical exercises (n=19, 57.6%), share the progress of physical exercise (n=19, 57.6%), and simulations on exercises to practice (n=15, 45.5%).

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3.2. Cooperative evaluation of the game design relative to physical exercise

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In terms of the main strengths and weaknesses of the game that was developed, the participants have revealed that the game challenges should be interlinked with the participants' context (indoors and outdoors). For example, some participants stated: "If the game could be incorporated in my daily life and entertain me during my trips and invite me going outside – that would be nice", "[...] For example, a challenge that enables us to link the information that was given to us with our daily life", and "We could have done these and other exercises outside." Bringing the players in both physical and digital (phygital) environments is, therefore, an essential aspect to consider when designing an age-friendly playable city and for ensuring the outdoor safety, information about local traffic signs, pavement conditions and wayfinding could help to create route guidance and walking assistance that are personalized to the older adult's context in terms of location, travel fitness, mobility conditions and motivations.

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Another highlighted aspect was the need to get immediate feedback towards action. Indeed, the participants were motivated to repeat and progress in the game with the use of immediate messages. For example, one of the participants argued: "You see? Congratulations, you won! I want to repeat it!" Similarly, social networks and the use of Key Performance Indicators were also relevant. As the participants point out: "I think that it is very important to check our performance – if we learn the information that is given. For example, a challenge that enables us to link the information that was given to us with our daily life." and "I would like to see my grade and how well I did when compared with others [...] But how can I see what I was missing and in which areas I performed better in comparison with my colleagues?"



### 223 3.3. Interview with Subject Matter Experts

224 In terms of the interviews with Subject Matter Experts, their perspectives on Recommendations  
225 for designing age-friendly environments and Designing for learning and behavior change were  
226 outlined.

227 According to the interviewees, age-friendly environments should: (a) foster social  
228 connectedness and demystify ageing bias; (b) take into account different age-cohorts when  
229 addressing products to this target group; (c) not focus on age-related difficulties or illness  
230 prevention; (d) train skills through cognitive challenges and foster life-long learning, establishing a  
231 strong with everyday life; and (e) make the participants familiar with the interfaces.

232 The following is some of the interviewees statements:

233 "[...] increasing social connectedness, reducing ageism and contributing to life-long  
234 learning. These aspects are very important to encourage active ageing [...] The other is  
235 not only focus on the disease or age-related difficulties, but to make designs that also  
236 focus on the positive aspects of ageing [...] risk of seeing older adults as their age-related  
237 difficulties, and having approaches only focus on reducing this, or increasing that. It is  
238 important that the person is respected as something beyond their age-related  
239 conditions." - Interviewee 9

240 "If you take somebody they understand TV, they understand the computer with Internet  
241 connection and they might be coerced to interact with a fitness band. Anything else, I  
242 think that it will be a struggle [...]" - Interviewee 1

243 "I think that we should really try to involve them because I think that older people is a  
244 diverse group including women, men, younger-old, old-old, higher educated and  
245 non-higher educated [...] Connect to their everyday life." - Interviewee 7

246 The interviewees also outlined the following recommendations to design for behavior change:  
247 (a) reinforce the presence if the player in the environment; (b) stimulate the players' subconscious  
248 by overweighting internal motivations (i.e. skills, beliefs, self-efficacy) and external elements that  
249 lead to Human behaviors; (c) use social elements, scenario building and changes in the game plot;  
250 (d) interlink between cognitive and affective dimensions; (e) strengthen the dialogue between both  
251 the game-design and the subject area; and (f) establish a link between games and outdoor activities  
252 and rely heavily on notifications. However, the interviewees drew our attention to the problem of  
253 manipulation of behaviors and too much focus on PBLs (Points, Badges and Leaderboards), in  
254 which information literacy can have an important role. As the interviewees state:

255 "Technologies can most definitely trigger changes in our behaviors at both the conscious and  
256 unconscious levels. For example, simple reminders on our phones can be helpful for  
257 medication adherence levels. For example, simple reminders on our phones can be helpful  
258 for medication adherence behavior. Technologies can also target our unconscious processes  
259 by releasing smells to trigger certain behaviors like eating." - Interviewee 8

260 "[...] a cognitive dimension and an emotional/affective dimension. I think that these two  
261 need to be interconnected but then need to think about the information from the start and  
262 the relational, emotional things are also important. It is a point I'd recommend that we look  
263 at when talking about behaviors – not only the cognitive dimension but also the affective  
264 one" - Interviewee 7

265 "I see some problems with using games and gamification to shape behavior, of course –

there is a huge ethical discussion even when using it for a good reason [...] All the techniques that we developed that can shape behavior could be caught by the army, advertisement or insurance. What I see in many gamification and serious games applications is a very behaviorist approach to human motivation, so you do something – you get a reward – you do something – you get a reward –you do something - you get a reward, which I think it can work in a short-term but I don't think it can go very far – you can't change behaviors in short-term but you can change mind-sets." - Interviewee 4

"Information literacy can assist in the changing of behavior as it encourages people to identify the need for information, locate it, evaluate it, and apply it to assist in changing of behavior. The information being sort has a role to play on the effectiveness of informational literacy. For example, health information can be activity pursued or avoided in order to delay the acquisition of the information. The pursuit of information in the case of health may depend on a variety of factors, such as an individual's traits and confidence" - Interviewee 10

#### 4. Discussion

The aim of this paper was to identify a set of necessary design requirements for designing an Age-friendly Playable City. Specifically, we identified a set of recommendations for designing age-friendly environments. Based on the previous assessment of the perceived benefits and motivations to physical exercise and the cooperative evaluation of the game design relative to physical exercise, the following design requirements were suggested: (a) enable the participants to schedule their activities and share their progress; (b) use Key Performance Indicators (KPI) (e.g. time frequency, accuracy of the exercises) and (c) reinforce social support networks.

The additional requirements were added based on semi-structured interviews with Subject Matter Experts: (a) take into account different age-cohorts, when addressing products to this target group; (b) do not focus on age-related difficulties or illness prevention; (c) establish a strong link with everyday life and familiarize the participants with the interface; (d) stimulate the players' subconscious by overweighting internal motivations (i.e. skills, beliefs, self-efficacy) and external elements that lead to Human behaviors; and (e) establish a link between games and outdoor activities. This interrelationship between indoor and outdoor activities suggests the potential of gamification and playful techniques to engage the end-users to provide information about local traffic signs, pavement conditions, wayfinding and, therefore, to help create route guidance and walking assistance personalized to the older adults' context in terms of location, travel fitness, mobility conditions and motivations.

A limitation of this study was the use of a convenience sample and further work needs to be conducted as attempts to generalize are not warranted and results should be interpreted with caution. Further efforts are being made to both extend the sample and integrating a set of missions that are personalized to the end-user context (location, travel fitness, mobility condition, motivations) and that take into account the social activities, information about local traffic signs, wayfinding, pavement conditions and time schedule through the use of gamification and playful techniques.

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